SEAN INSTITUTE
Sharing Knowledge
http://infor.seaninstitute.org/index.php/infokum/index
JURNAL INFOKUM, Volume 9, No.1, Desember 2020 **ISSN : 2302-9706**

DIGITAL IMAGE ENHANCEMENT USING THE METHOD OF MULTISCALE RETINEX AND MEDIAN FILTER

Mhd. Furqan [1], Abdul Halim Hasugian [2], Rizqi Hidayat Tanjung [3]
[1,2,3]Universitas Islam Negeri Sumatera Utara
Email : 1 mfurqan@uinsu.ac.id, 2 abdulhalimhasugian@uinsu.ac.id, 3 riskytanjung214@gmail.com

Abstract

At this time digital image used by a lot of people to capture the moment or other important things, digital image itself is the result of shooting with a digital camera, although today's digital cameras are already equipped with features that support the results of the picture, but not all digital image that is produced in accordance with our wishes, it happens because of a problem on the quality of the image, situation and condition at the time of the shooting process the image will affect on the quality of the image causes the image results to be bright or dark. Then from that needed improvement of the quality of the image so that the image that is produced in accordance with our wishes, in this study, the methods used in improving the quality of image is using the method of Multiscale Retinex and Median Filters. The process of Multiscale Retinex will produce the image of a more bright compared to the original image that minimal light intensity, while the Median filter will produce a clearer image because it can reduce the noise/noise in the image, the parameters used in this study is Histogram of some data that has been researched histogram chart shows the value of the intensity of the pixel average is close to zero (0) after processed by the method of Multiscale Retinex and the Median Fiter value of the intensity of the pixel average show a change of the charts is approaching 250 which indicates an increase in the brightness of the digital image brighter.
Keywords : Digital Image, *Multiscale Retinex*, *Median Filter*, *Histogram*

1. Introduction

The rapid development of technology means that in the field of industrial technology level of the world now has shown towards mobility level is very complex, one form of progress in the field of technology is the presence of a metaphor in the form of illustrations of the objects are optic for example, just like the picture on the television screen that are analog, specialized signal-video signal, or is digital that can be directly stored on the storage medium is called the image.

But sometimes the image is not always produced in accordance with the wishes. The image of the sometimes experience interference in the form of degradation or decrease in the quality of it is due to interference noise/noise, the contrast is too high, opaque and others. The disorder is caused by a variety of actors in the form of the lack of light rays when the process of taking the image, the lack of pixel resolution of the camera used, and the limited ability to capture image, Process the image is degraded and improve the quality known as image enhancement. Image enhancement is important for image analysis, diagnosis, and display. The purpose of image enhancement is to get the detail of the picture that is smooth and highlighting useful information.

Retinex is an algorithm of image enhancement of nonlinear that simulates the human visual system. Algorithm retinex has konstansi color, high dynamic range and can also sharpen detail, By using the method of Multiscale Retinex we can improve the image quality on the brightness so as to produce a better image. Methods retinex delivered by Edwind Land in 1971.

2. Literature Riview

2.1 the Image

Webster's dictionary states the image is a likeness of the object of objects, & an illustration, for example the results of the images that belong to someone coming from the camera are used, photos of X-rays of the thorax which is taken to represent the image of the body part of the person and others.

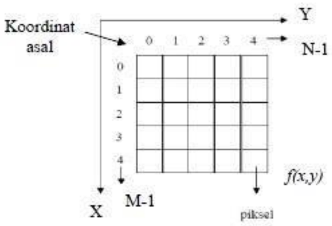
The image is a picture of something in the form of the object. The image is divided into two, namely the image of the analog and the digital image, to be optic the form of a photo or a video signal as the image on the television screen is the image of analog, or that can be directly stored on a storage media is a digital image.

2.2 Digital Image

In general, digital image leads to an image processing 2 dimensions using a computer. The process of data 2 dimensions leads to digital image processing. Digital image is an array (arrays) which contain a real value is represented along with the particular bit sequence.

The image defined by x and y is the spatial coordinates, the coordinates (x,y) is called intensity or gray level of the image at that point. with the function f(x,y) of size N rows and M columns, If the value of x,y, called that that image is a digital image if the value of the amplitude f thoroughly finite (finite) and has a discrete value.

The digital image can be written in matrix form as shown below :



$$f(x,y) = \begin{bmatrix} f(0,0) & f(0,1) & \dots & f(0,M-1) \\ f(1,0) & \dots & \dots & f(1,M-1) \\ \dots & \dots & \dots & \dots \\ f(N-1,0) & f(N-1,1) & \dots & f(N-1,M-1) \end{bmatrix}$$

Figure 1 The Coordinates Of The Image Digital

Figure 2 Matrix Digital Image N x M

ficture elements, image elements, pels, or pixel values at a wedge between rows and columns (at position x,y) is most often used in the digital image.

2.3 Improvement Of The Quality Of The Image

Improving the image quality (image enhancement) is the initial stage of image processing (image processing). Quality improvement is needed because it is often found the image quality is not good, such as image noise (noise) at the time of the delivery process image, the image light/dark, blurred, the image less sharp, and more. At this stage the image quality can be improved so that the image can be is better.

2.4 Retinex

Methods retinex delivered by Edwind Land in 1971. The main goal of the algorithm retinex is to separate the image of S into 2 (two) image of different, namely reflectanceimage R and illumination image L at any point (x,y) in the image domain. retinex is subdivided into several sections including, *Singlescale Retinex* (SSR) and *Multiscale Retinex* (MSR), *Singlescale Retinex* (SSR) is the process before beginning the process of *Multiscale Retinex (*MSR), through a three phase SSR.

3. Results and Discussion

3.1 *Singlescale Retinex*

Singlescale Retinex (SSR) is the process before beginning the process *of Multiscale Retinex* (MSR), through a three phase SSR. The following formula *Singlescale Retinex* :

$$Ri(x,y) = \log Ii\,(x,y) - \log\,[F(x,y)*Ii\,(x,y)]$$

Description :
Ri(x,y) = Is the Output Retinex
Li(x,y) = the Distribution of the Image
F(x,y) = Function of the Gaussian

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}}$$

Description :
G(x,y) = Is a gaussian kernel pixel
π = Constant 22/7
σ = Is the value of sigma
e = Is a provision 2.7182818246
(x,y) = Coordinates of the Pixel

Convolution is a calculation done by performing the multiplication between a matrix f and the kernel of g. The method of Convolution can be expressed in a matrix, where each element of the matrix percolator is the coefficient of the convolution. The result of the multiplication convolution will be stored into the matrix that was just done with how to do the shift kernel pixel per pixel.

Figure 3 Digital Image

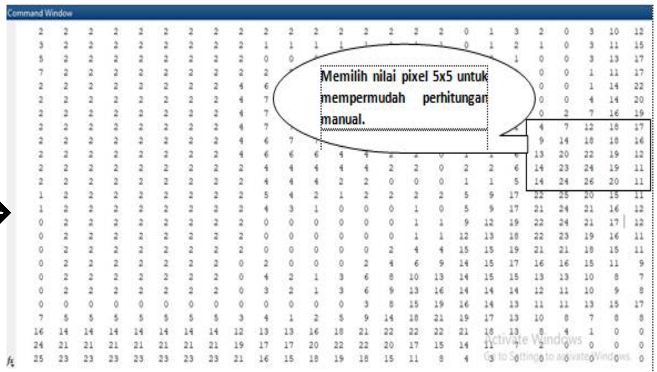


Figure 4. Pieces of the Value of the Pixel RGB

Table 1 Pieces Of Pixel Values

0	0	0	0	0	0	0
0	4	7	12	18	4	0
0	9	14	18	18	3	0
0	13	20	22	19	7	0
0	14	23	24	19	26	0
0	14	24	26	20	25	0
0	0	0	0	0	0	0

As for Example the calculation of the manual :
The initial stage is done is to do the calculation to get the value of the Gaussian, following :

Where : σ = a sigma
π = 22/7
e = 2,71828182846

For example σ = 8,5

$$\begin{pmatrix} \frac{1}{2\pi(8,5)^2} e^{-\frac{-1^2+1^2}{2(8,5)^2}} & \frac{1}{2\pi(8,5)^2} e^{-\frac{0^2+1^2}{2(8,5)^2}} & \frac{1}{2\pi(8,5)^2} e^{-\frac{1^2+1^2}{2(8,5)^2}} \\ \frac{1}{2\pi(8,5)^2} e^{-\frac{-1^2+0^2}{2(8,5)^2}} & \frac{1}{2\pi(8,5)^2} e^{-\frac{0^2+0^2}{2(8,5)^2}} & \frac{1}{2\pi(8,5)^2} e^{-\frac{1^2+0^2}{2(8,5)^2}} \\ \frac{1}{2\pi(8,5)^2} e^{-\frac{-1^2+-1^2}{2(8,5)^2}} & \frac{1}{2\pi(8,5)^2} e^{-\frac{0^2+-1^2}{2(8,5)^2}} & \frac{1}{2\pi(8,5)^2} e^{-\frac{1^2+-1^2}{2(8,5)^2}} \end{pmatrix}$$

$$\begin{pmatrix} 0.0021765393 & 0.0021887541 & 0.0021765393 \\ 0.0021887541 & 0.0022039538 & 0.0021887541 \\ 0.0021765393 & 0.0021887541 & 0.0021765393 \end{pmatrix}$$

Quantity : 0.0196651274
the Overall number of matrix elements after the summed result amounted to 1, otherwise the value is 1 then the re-calculation, the formula used is as follows :

$New\alpha = \alpha x \frac{1}{Total}$

$New\alpha_{(1,1)} = 0.0021765393\ x \frac{1}{0.0196651274} = 0,110670999$

$New\alpha_{(1,2)} = 0.0021887541\ x \frac{1}{0.0196651274} = 0,111301293$

Do the calculation on all elements of the matrix, in order to get the results as below:

$$\begin{pmatrix} 0,110670999 & 0,111301293 & 0,110670999 \\ 0,111301293 & 0,112074219 & 0,111301293 \\ 0,110670999 & 0,111301293 & 0,110670999 \end{pmatrix}$$

The value of the conversion that is produced is the calculation of the pixel values of the image from the beginning and the Gaussian kernel. the next step is surgery the meeting with the process perpolongan kernel.then do perklian and sum with the value of the Gaussian in order to get the results from the dissolution of *F(x,y)*G(x,y).*

0	0	0	0	0	0	0
0	4	7	12	18	4	0
0	9	14	18	18	3	0
0	13	20	22	19	7	0
0	14	23	24	19	26	0
0	14	24	26	20	25	0
0	0	0	0	0	0	0

F(x,y)

0,11067099	0,11130129	0,11067099
0,11130129	0,11207421	0,11130129
0,11067099	0,11130129	0,11067099

G(x,y)

• The calculation is done as follows:
(0 x 0,11067099) + (0 x 0,11130129) + (0 x 0,11067099) + (0 x 0,11130129) + (4 x 0,11207421) + (7 x 0,11130129) + (0 x 0,11067099) + (9 x 0,11130129) + (14 x 0,11067099) = 3,77851134
Next slide the kernel one pixel to the right, then do the calculations on the position of the (0,0) of the kernel, like the previous one, do the calculations for all values of the matrix .

Table 2 The Results Calculation Of The Convolution SSR_1

3,77851134	*7,1116749*	*9,67231767*	*11,01131007*	*7,68158325*
7,44712461	13,22352909	16,44616428	16,89199974	11,11917462
10,33774683	17,44879143	19,67069037	17,66809989	10,55957649
12,003627	20,00473686	21,89258931	18,22334574	10,2236391
8,34392073	13,90725993	15,13059876	12,34784109	6,78590511

Then Do the calculation of the value of the matrix SSR_1, SSR_2 dan SSR_3
SSRn(x,y) = $\log l_n(x,y) - \log G_n(x,y)$
Where, $\log l_n(x,y)$is a *pixel* image of the begining.

- 4 – 3,77851134 = 0,22148866

do the calculation with the entire value of the pixel, then the result can be seen in the table below.

Table 3 Results SSR_1

0,22148866	**-0,1116749**	**2,32768233**	**6,98868993**	**9,31841675**
1,55287539	0,77647091	1,55383572	1,10800026	4,88082538
2,66225317	2,55120857	2,32930963	1,33190011	1,44042351
1,996373	2,99526314	2,10741069	0,77665426	0,7763609
5,65607927	10,09274007	10,86940124	7,65215891	4,21409489

Table 4. Results SSR_2

0,22046906	**-0,11285898**	**2,32148603**	**6,97758115**	**9,30431623**
1,54984465	0,77426643	1,55115728	1,1036576	4,87262728
2,65743891	2,54589229	2,32411105	1,32937601	1,43567319
1,99209504	2,98945498	2,10232981	0,77426658	0,77426634
5,64558087	10,07464537	10,8502238	7,63767567	4,20597087

Table 5. Results SSR_3

0,22527534	**-0,1067625**	**2,35074762**	**7,0227069**	**9,36167453**
1,5622187	0,78253515	1,55920106	1,12342429	4,90609185
2,6768332	2,56710643	2,34475978	1,33686034	1,45844419
2,0098229	3,01175822	2,12241313	0,7825055	0,78255294
5,69168615	10,153144	10,93278604	7,70155649	4,2420814

3.2 *Multiscale Retinex*

Multiscale Retinex (MSR) is a generalization of the *retinex* (SSR) a single scale, which, in turn, is based on the last version of the retinex center / surround Land, the following is the formulation of the original *MultiScale Retinex*.

$$R_{msr_i} = \sum_{n=1}^{N} W_n R_{n_i}$$

Description :

R_{msri} = results from MSR
N = the Number of the scale used
W_n = the Weight of each input SSR
R_{ni} = Output SSR
i = channel Rgb colors

the parameters in the MSR, among others :
1) The Number Of The Scale (N), The number scale used is 3 the number.
2) Sigma used (σn),Sigma in the parameters consist of the three combinations of high, medium, and low.
3) The weights for each input SSR (wn), Weighting in the process of MSR result should be = 1. For example, if N=3, then Wn = W1+W2+W3, where Wn = 1.

At the stage of doing the calculations so that the results MSR obtained that perform the summation of the pixel values from the results of the calculation of the SSR_1, SSR_2 dan SSR_3 and do the multiplication on the value of the weights is 1, so that the results obtained from the calculation of the Multiscale Retinex.

Table 6. Results Of The Calculation Of Multiscale

0,66723306	**-0,33129638**	**6,99991598**	**20,98897798**	**27,98440751**
4,66493874	2,33327249	4,66419406	3,33508215	14,65954451
7,99652528	7,66420729	6,99818046	3,99813646	4,33454089
5,99829094	8,99647634	6,33215363	2,33342634	2,33318018
16,99334629	30,32052944	32,65241108	22,99139107	12,66214716

After getting the results of the calculation of the Multiscale Retinex, the pixel values of the Multiscale Retinex normalized by the formula :

New Value : $\frac{abs\ (value-min)}{(max-\min)} * 255$

From the results of the calculation of the MSR get results :
The largest value = 32,65241108
The smallest value = -0,33129638
Based on the color range from the smallest value to the largest is (0 – 255), then the pixel value of the largest (32,65241108) is 255 and the minimum value (-0,33129638) is 0.
After the calculation of the normalization, the results obtained as in the following table :

Table 7 Results Of The Normalization

7	**0**	**56**	**164**	**218**
38	20	38	28	115
64	61	56	33	36
48	72	51	20	20
133	236	255	180	100

3.3 *Median Filter*

The process of the median filter is done by performing a shift of the kernel and then the pixel values contained in the kernel in the sort from the smallest value to largest then he found the middle value. The process of shifting the kernel is performed on all pixel values that are there.

Table 8. The Pixel Values *Multiscale Retinex*

7	0	56	164	218
38	20	38	28	115
64	61	56	33	36
48	72	51	20	20
133	236	255	180	100

F (x) = 0, 7, 20, 38, (38), 56, 56, 61, 64

Then the results of the search for the ninth kernel/mask is 63, then that value will be inserted as the value of the middle pixel of the new.

Do the Calculation of the median filter on all the value of the pixel on the matrix, so that the obtained Output image median filter as shown in the table below :

Table 9 results of the Output of the Median Filter

7	0	56	164	218
38	38	38	56	115
64	51	38	36	36
48	64	61	51	20
133	236	255	180	100

3.4 Testing The Application

Figure 6. the Results of the Process MSR

Figure 7 The Results Of The Process Median

Citra Asli	Citra *Multiscale Retinex*	Citra *Median Filter*

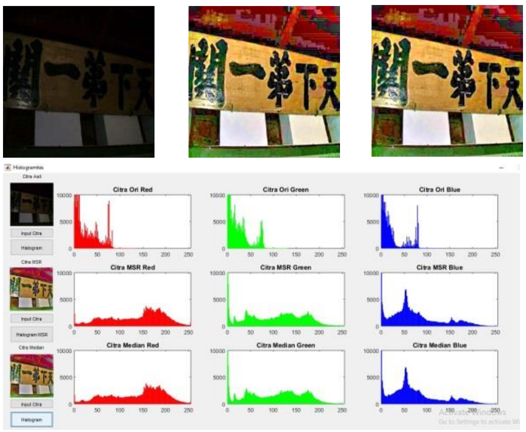


Figure 8. Results of Digital Image and Histogram

4. Conclusion

From the results of the application of the method of *Multiscale Retinex* and the *Median filter* which has been done, the method of *Multiscale Retinex* can be used in the brightening of a digital image while the method of *Median Filter* can be used in to clarify a digital image to reduce noise/noise contained in the image of the digital.

The method of *Multiscale Retinex* produce the image that are brighter than the original image and the method of *Median Filter* produces a clearer image compared with the image of the *Multiscale Retinex* process prior to the *median filter*, as a comparison of the results of the image can be seen in the histogram of some data that has been researched histogram chart shows the value of the intensity of the pixel average is close to zero (0) after processed with Multiscale Retinex and the Median Fiter value of the intensity of the pixel average shows the change chart approaching 250.

Reference

[1] Affandi Muhajir, (2018). *Teknologi Informasi & Komunikasi Dalam Pendidikan*. Kuningan : YNHW

[2] Bangalore, T. (n.d.). *Color Image Enhancement using Multiscale Retinex with Modified Color Restoration Technique*.

[3] Hasugian, A. H., & Zufira, I. (2018). Perancangan Sistem Restorasi Citra Dengan Metode Image Inpainting. *Jurnal Ilmu Komputer Dan Informatika*, *03*(November), 31–45.

[4] Hong-wei, Z., & Jiu-gen, Z. (2018). *Color Image Enhancement Using Multiscale Retinex Based on Particle Swarm Optimization Method Color Image Enhancement Using Multiscale Retinex Based on Particle Swarm Optimization Method*. 6–12.

[5] Li, B., Wang, S., & Geng, Y. (2011). *Image Enhancement Based On Retinex And Lightness Decomposition Bo Li, Shuhang Wang, Yanbing Geng Digital Multimedia Laboratory, Computer Science and Engineering, Beihang University, Beijing 100191*. 3478–3481.

[6] Purba, B. (2017). *Aplikasi Perbaikan Kualitas Citra Hasil Penginderaan Jauh (Remote Sensing) Dengan Metode Contrast Stretching*. *VI*(2), 26–36.

[7] Putra Darma. (2010). Pengolahan Citra Digital. Yogyakarta : Andi

[8] Parihar, A. S., & Singh, K. (2019). A study on Retinex based method for image enhancement. *2018 2nd International Conference on Inventive Systems and Control (ICISC)*, *April*, 619–624.

[9] Rahman, Z., Jobson, D. J., Woodell, G. A., & Science, C. (n.d.). *Retinex Processing for Automatic Image Enhancement*.

[10] Supriadi, D., Novantara, P., Ilmu, F., & Universitas, K. (2017). *Implementasi Metode Multiscale Retinex Untuk Image Enhancement* .

[11] Syamsuddin, S. (2019). Aplikasi Peningkatan Kualitas Citra Menggunakan Metode Median Filtering Untuk Menghilangkan Noise. *SISITI: Seminar Ilmiah Sistem Informasi Dan Teknologi Informasi*, *8*(1), 227–236.

[12] Tarigan, A. K., Nasution, S. D., & Karim, A. (2016). *Aplikasi Pembelajaran Citra Dengan Menggunakan Metode Computer Assisted Instruction (Cai)*. *3*(4), 1–4.